Implementation of ACASS - Accident Causation Analysis with Seven Steps – in In-Depth Accident Study GIDAS

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Abstract
As the official German catalogue of accident causes has difficulty in matching the increasing demands for detailed psychologically relevant accident causation information, a new system, based on a "7 Steps" model, so called ACASS, for analyzing and collecting causation factors of traffic accidents, was implemented in GIDAS in the year 2008. A hierarchical system was developed, which describes the human causation factors in a chronological sequence (from the perception to concrete action errors), considering the logical sequence of basic human functions when reacting to a request for reaction. With the help of this system the human errors of accident participants can be adequately described, as the causes of each range of basic human functions may be divided into their characteristics (influence criteria) and further into specific indicators of these characteristics (e.g. *distraction from inside the vehicle* as a characteristic of an *observation-error* and *the operation of devices* as an indication for *distraction from inside the vehicle.* The causation factors accordingly classified can be recorded in an economic way as a number is assigned to each basic function, to each characteristic of that basic function and to each indicator of that characteristic. Thus each causation factor can be explicitly described by means of a code of numbers. In a similar way the causation factors based on the technology of the vehicle and the driving environment, which are also subdivided in an equally hierarchical system, can be tagged with a code. Since the causes of traffic accidents can consist of a variety of factors from different ranges and categories, it is possible to tag each accident participant with several causation factors. This also opens the possibility to not only assign causation factors to the accident causer in the sense of the law, but also to other participants involved in the accident, who may have contributed to the development of the accident. The hierarchical layout of the system and the collection of the causation factors with numerical codes allow for the possibility to code information on accident causes even if the causation factor is not known to its full extent or in full detail, given the possibility to code only those cause factors, which are known. Derived from the systematic of the analysis of human accident causes ("7 steps") and from the practical experiences of on-scene interviews of accident participants, a system was set in place, which offers the possibility to extensively record not only human causation factors in a structured form. Furthermore, the analysis of the human causation factors in such a structured way provides a tool, especially for on-scene accident investigations, to conduct the interview of accident participants effectively and in a structured way.

Introduction and objective

Accidents happen as consequence of disregarding traffic rules and a conflict situation between the road users, whose temporal movement leaves no room for avoiding a collision. The police accident documentation contains a kind of determination of accident causes, which is oriented however at criminal offences and irregularities committed. These causes of accidents are part of the official accident statistics for Germany and are also being used in a similar form in national accident statistics of other countries, amongst others in IRTAD und CARE. The **I**nternational **R**oad **T**raffic and **A**ccident **D**atabase IRTAD is an international database that gathers data on traffic and road accidents from 28 of the 30 OECD Member countries, the European database CARE (**C**ommunity database on **A**ccidents on the **R**oads in **E**urope) is a Community database on road accidents in European member states, collecting data on accidents resulting in death or injury (no statistics on damage - only accidents). The major difference between CARE and most other existing international databases is the high level of disaggregation, for both, however, the data collected by the police are used exclusively for the description of the accident and they contain no statements on the cause of the accident. Nevertheless, the official national accident statistics also contain a characteristic marked as cause of accident, which is determined primarily by the police immediately after the acquisition of accident data from the apparent circumstances. These causes of accident specified by the police do not contain a reconstruction of the accident event, based on which an excessive driving speed, for example, or the actual visibility conditions at the site of the accident would be considered in the cause evaluation. Also the frequently given cause "alcohol" is stated exclusively as a fact, based on finding blood alcohol levels, the actual effect of the alcohol on the accident emergence is not proven. For many years there have been efforts to conduct an adequate evaluation of the causes of accidents, usually in scientific studies of psychologically oriented scientists, who analyzed interviews of persons having been involved in an accident, compared to those of control groups without accident. Into the 70s so-called

In-Depth-data collections were used, where a team at the site of an accident questioned persons involved in accidents and thus collected information on failure and behavior patterns (Wanderer et al. 1974). In-Depth-collections open the possibility to understand not only the kinematic and biomechanical operational sequence of the accident, but also of creating the human system-component from his reported or observed behavior, from his memory and his evaluation of the course of the accident and thus access an analysis of accident causes. In a study conducted for the Federal Highway Research Institute, Germany (Pund et al. 1994), suggestions were made, based on a bibliographical evaluation and different method variations, which accommodate both research based on an analysis of the accident participant as well as the conditions of an accident research working on-scene.
In the past years many of the conducted safety measures concentrated on the avoidance and reduction of injuries and injury severity in case of an accident (measures of passive safety). Measures for the avoidance of accidents (measures of active safety) were so far conducted usually sporadically and were advanced individually by transport authorities and road and town planning. They were based on police collections and the official system of accident causes. Only recently analyses of causes of accidents also put emphasis on optimized safety strategies in automotive engineering and research on accidents. In that way the relatively increasing numbers of accidents due to the increase of the vehicle population and the mileage can be encountered with decreasing numbers of fatalities and severely injured persons. In particular the use of intelligent technical aids like vehicle assistant systems, currently being intensified, such as navigation systems, brake assistants, lane departure warning, adaptive Cruise control, it becomes more and more difficult to evaluate the contributions of these electronic systems implemented in the vehicle on accident influence and accident avoidance. Thus active safety and above all the knowledge of the causes of traffic accidents seem to play an ever-increasing role.

The objective thus has to be to compile an evaluation-neutral coding system of causes of accidents and/or accident influence parameters on the accidents, which can be used within the procedures of accident research. This system has to contain the individual components "human-vehicle-environment" and has to supply a methodology for the collection of important information, it also has to make the causes and/or influence parameters available for computer-based evaluation. To this end at first a suitable system has to be developed and the relevant parameters have to be defined. In a second step these can be coded and a technical and practical coding structure can be developed. For In-Depth data collections on scene it would be particularly helpful, if the developed system could not exclusively be applied by psychological specialists, but also by other researchers after a psychological and system-oriented training. Beyond that it is well known from past on scene accident research and other in-Depth-collections that not always all information concerning the accident is available and that the persons involved or injured in an accident are not always available for questioning. Even in these cases without direct interview of the involved parties the causes of the accident and/or the influencing parameters should still be analyzable.

From these multivariate requirements it was possible to develop a methodology (ACASS – Accident Causation Analysis with Seven Steps), which is to aid the on-scene accident research GIDAS (German in-Depth-Accident Study) and which is in use since the beginning of 2008. GIDAS' special feature is a statistically representative sample appropriate for all types of accidents with personal injury collected by an on scene investigation team consisting of physicians and engineers and a very comprehensive, detailed compilation of the accident data by means of more than 2000 items of information for every accident, concerning injury and deformation patterns, driving and collision speeds as well as other accident characteristics, and, in addition, information from questioning persons involved in the accident (Otte et al. 2003 and Bruehning et al. 2005). In the context of this study the newly developed methodology and structure of the causation coding in GIDAS by means of ACASS and the first results of the application in GIDAS, implemented at the beginning of 2008, are illustrated.

Psychological basis of methodology

Apart from the collection of technical and infrastructural characteristics the analysis of the human "variance " during the accident development contributes to the explanation of causes (cf. PUND & OTTE, 2005). Therefore the influence of the situationally effective behavior is recorded in the context of an analysis of the persons involved as soon as as possible after the accident and if possible at the site of the accident (for the reasons, cf. PUND & NICKEL, 1994). The explorative analysis of accident causes in seven steps ("Seven steps" method) based on traffic-psychology considers the dynamic process character of human functions, which play a role in the avoidance of collisions when coping with a traffic conflict.

The analysis of causes of accidents starting with the event (in contrast for instance to the traffic conflict research) the conditions effective at the time of the critical event are examined as extensively and exactly as possible, on the other hand looking backwards on a time axis conditions, which were the cause of the accident are tracked. The latter applies particularly to the human contribution: Conditions like fog or icy roads as such relatively rarely represent causes of a certain accident (otherwise all road users would have been involved in an accident at the observed accident site under these conditions), but only become an identifiable cause in connection with human processes. Human conditions unfold interactively-dynamically, occur iteratively-process-like and are subject to a high variance. Perception, evaluation and decision procedures, for instance, depend to a high degree on basic functions, which humans bring into the accident situation and which also change and adapt in the course of events, e.g. a "switching" from a more distributed attention attitude to a focused one.

If one considers the structure of an accident causation analysis, one arrives at the rather complex representation of the possible influence parameters relevant in this context (figure 1). From this the approach of a system-oriented recording of accident influence parameters and the ACASS-methodology were developed.

The systematics used for ACASS in the context of the GIDAS accident research contain an explorative classification of characteristics affecting accidents, which occur during the analysis of accidents. Causation factors are relevant single characteristics or combinations of characteristics, which were causal for the development of a traffic accident, or which contributed to the development of the accident. For traffic accidents these factors can be expected to originate from the areas "human", "machine" and "environment".

"Human“ → Group 1, human cause factors (Seven Steps)
„Machine“ → Group 2, factors from the technical nature of the vehicle
"Environment“ → Group 3, factors from the range of the infrastructure and nature

Group 1 with its 7 subcategories is the seven-steps method and thus the core of this system for collecting causes of accidents, which can be attributed to human behavior.

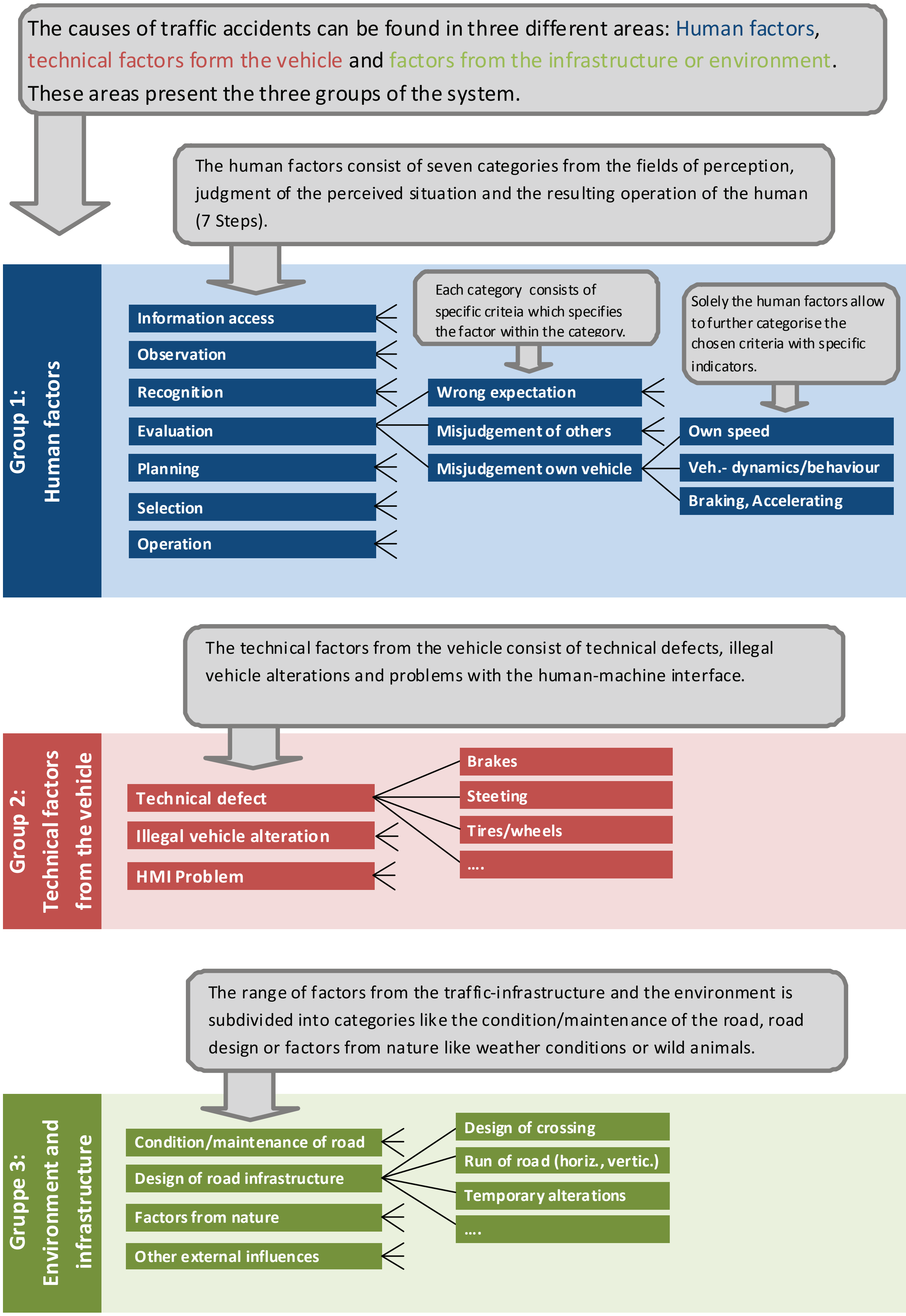

Figure 1: Structural-analytical view of causes of accidents in the human-vehicle-environment-model

ACASS not only is a system for recognizing and describing causation information but also for collecting them in a data base, by categorizing them using a system of numeric codes. Such a system requires additional information apart from the concrete influence parameters of the cause of the accident, in order to be able to deliver as complete a picture of the accident as possible. As can be seen in figure 2, for each accident participant a set of codes is collected, which contain information on the causes of the accident and the source of the corresponding information as well as their reliability. Besides for each causation code an explanatory text is given in a text field.

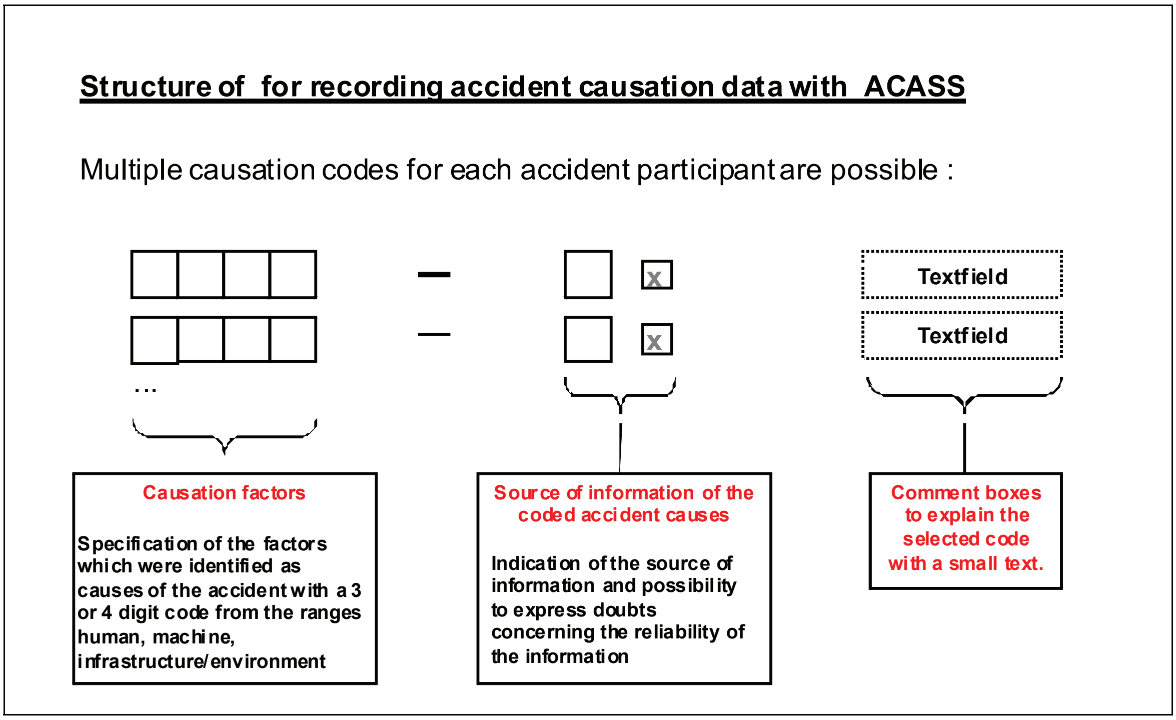

Figure 2: Overview over the data to be encoded for ACASS.

Cause factors

The cause factors constitute the core of the system for the collection of accident causes. The cause factors specific to traffic accidents are summarized in a catalog, which covers the ranges human, machine and environment. Each recognized cause, which has been considered relevant for the respective traffic accident, can be assigned a code, consisting of 3 or 4 numbers. Frequently a combination of several cause factors is responsible for the development of a traffic accident, thus the indication of only one cause of accident would not be sufficient. For this reason there is the option of assigning several cause factors to each person involved in an accident.

Source of information of the coded causes

Here the source of information of a factor can be indicated for each coded cause factor. During the accident investigation and the collection of the causes of the accident frequently possible causation factors are found, which may or may not have contributed to the development of the accident. Often even people involved in the accident also indicate or assume causes, whose relevance may be doubted. For this reason the source of the information of the respective causation factor can be number coded: *(1) questioning of the involved person at the site of the accident; (2) questioning of the involved person in hospital; (3) retrospective interview of the involved person by telephone; (4) retrospective questioning of the involved person in person; (5) questioning of another involved person; (6) questioning of eye-witnesses; (7) information by the police; (8) information from accident reports/official records; (9) estimate of the accident research team.*

To have the opportunity of expressing doubts about a cause of the accident expressed by third parties, there is the possibility, apart from the indication of the source of information, of marking a check box expressing the doubt of the accident researcher, while the cause factor is being recorded in the data base.

Further relevant information
To be able to piece together a complete picture of the development of the traffic accident at a later point in time, it is sensible to collect descriptive information of the constellation of the accident in addition to the cause factors.
For this purpose a text describing the accident is suitable as well as recording the type of the accident in accordance with the GDV (General Association of German Insurance Companies - Gesamtverband Deutscher Versicherer)/ISK (Institute for Traffic Cologne - Institut für Straßenverkehr Köln). This is another 3-digit code, based on the classification in 7 main classes and subsequently in several subclasses of the respective main classes.

Causation factors of traffic accidents

A number of investigations on causes with traffic accidents, already conducted, showed that most causation factors are to be found within the range "human". Due to this relevance the Seven step system was developed, which divides the human factors in 7 categories within group 1. Together with the factors from the range of the technology of the vehicle and the factors from the ranges "nature/infrastructure" three different groups emerge, in which causation factors for traffic accidents can be found. These 3 groups constitute the first digit of the cause code.

Illustration 3 shows that the causation factors of the three mentioned groups are divided in each case into up to seven subcategories within the groups.

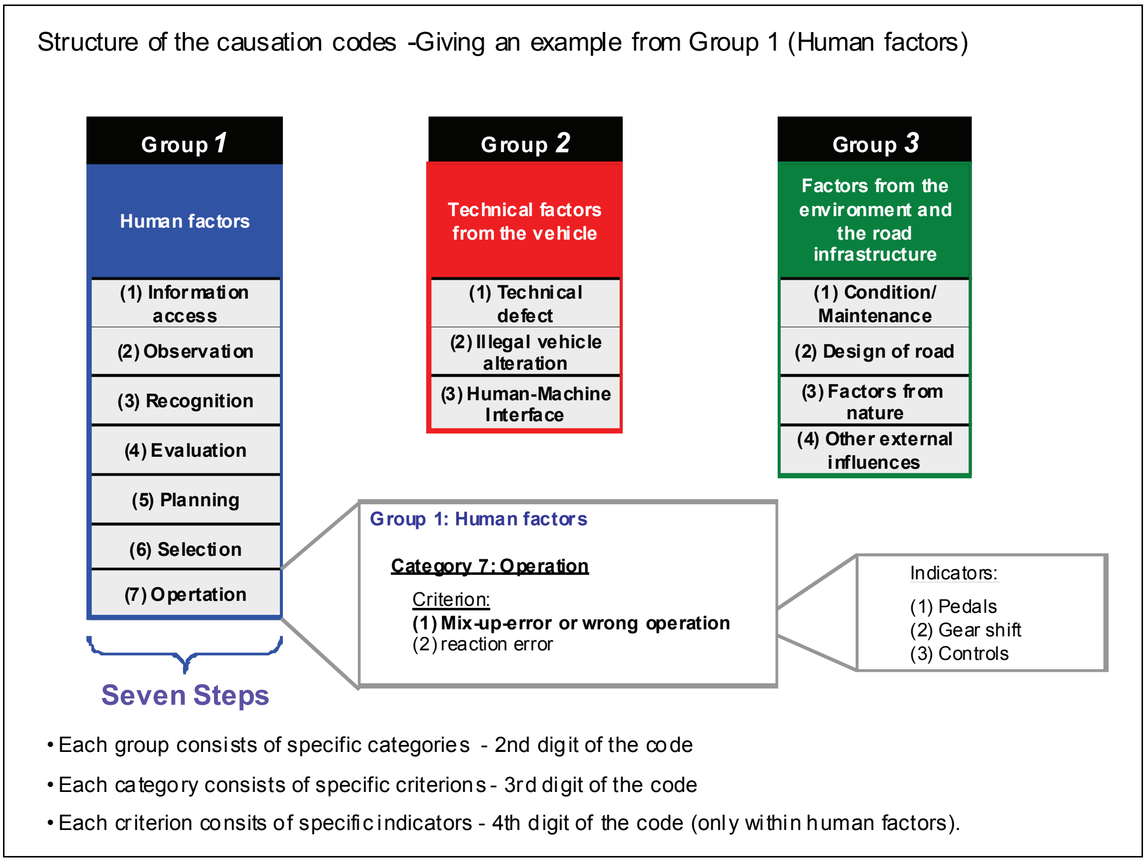

Figure 3: Structure of the causation code.

The respective categories constitute the second digit of the causation code. The third number of the causation code is determined by the concrete causes or by the influence criteria within the respective categories. This has been represented as an example of subcategory (7) "Opertation" within Group 1 (human factors). For human cause factors, however, there is an additional fourth number (indicator). Each influence criterion has a set of indicators, which indicate frequent occurrences of these influence criteria. Using the example (1) of "mix-up and operating error" from group 1, category 7, the most frequent occurrences were (1) pedals; (2) gear shift; (3) control elements. The fourth digit of the code is used to specify the appropriate indicator applicable here. If a mix-up of gas and brake pedal were a cause for a traffic accident, the appropriate cause code for that constellation would be 1711, for instance.

Explorative analysis of causes of accidents due to human factors in seven steps (Seven steps)

The 7 categories (seven steps) of the human cause factors in group 1 are an analysis and order system, which describes the possible human causation factors at the moment of the accident development in chronological order (from perceptibility to action errors). These seven steps are first based on error tracing in the top category of the "information access" and subsequently on the basic 6 human functions (from "observing" to "operating"), which run in chronological order from recognizing the danger up to the reaction to a cause, e.g. a traffic situation evaluated as critical. Based on this structure, the human cause factors can be divided not only into meaningful categories, but can be recognized and collected more easily because of a structured questioning method.

As process model Seven steps takes into account the dynamic sequences, which develop, if a human with his characteristics, abilities and restrictions intervenes in a system. The core method of interviewing the persons involved created a structure of the procedure of data acquisition. The identification of causes of accidents in human behavior should consider the process character of human observation, thinking and acting, in order to arrive at manageable analysis units, which permit clear statements as to the respective human sources of error on distinguishable "function levels". A procedure based on hypotheses lends itself for this purpose, where for every step within the processing concept of the seven steps a core hypothesis is presented, which can be disproved using certain criteria. The respective criterion again experiences its validity of the allocation by different indicators, which are collected at the site of the accident in a predominantly explorative manner.

Result of an application orientated study

The methodology of the collection of accident causes was presented for the first time at the first international conference "Expert symposium on Accident Research" (ESAR) in September 2004. After a testing phase it has been used in this shape by GIDAS in the course of the ongoing analyses of accidents at the medical university Hanover. The model it is based on has been theoretically justified and its implications for application on the special conditions of an "In-Depth/On-the Spot" analysis were derived (PUND and OTTE, 2005). Within two years of developing work, the model underwent a definition and an adjustment taking into account the feasibility and restrictions of the research at the sites of accidents, where the aspect of the "feasibility" and the realistically executable time and effort for data acquisition and coding was focused on (PUND, OTTE and JAENSCH, 2007). A further objective was as high an agreement of the model structure with the collection instruments derived from it as possible and their adjustment to the half-standardized interview form used up to that time (cf. PUND and OTTE, 1999).

The analysis of the human causation factors of accidents in seven steps is now a variable set of group 1 of the causation codes, besides the "factors of influence from the range of the vehicle technology" of group 2 and the "factors of influence from the range of the infrastructure and environment" of group 3 (cf. diagram 3).
On the basis of interactive models of the traffic participation and accident development, the model of the Seven Steps is based on an information-theoretical access; it considers action theoretical explanation approaches and covers components of the error analysis. Models of the procedural data processing generally assume step procedure "perception - interpretation - decision - action" and also consider the interfaces of the "human factor" with other system components (in summary e.g. HEINRICH and PORSCHEN, 1989; WILLUMEIT and JUERGENSOHN, 1997; WICKENS, 2000). The approach of process description of the information acquisition, its cognitive processing, the intention and goal formation, which are based on the above, as well as their conversion into actions have been integrated into the model, just like the observation of human processes as sequential

functions from the perception of a critical attraction to the execution of the action. The "disturbance" identified in the respective step of the hierarchically structured flow chart, describing the human basic function in detail is perceived as an error during the process of the information processing and action conversion (e.g. REASON, 1994; RASMUSSEN, 1986, 1995; KUETING, 1990), the failure of a basic human function is explained due to effective physiological or psychological factors, e.g. perception errors due to distraction; decision errors due to unsolvable conflicting objectives or action errors due to coordination errors (see tri level study; TREAT et al., 1977). The role of the motivation of the drivers concerns above all the risk evaluation of a situation and the driver's behavior, thus questions concerning the motivational conditions, particularly in the steps "estimate" (interpretation of the recognized characteristics) and "planning" (action draft due to intention formation) are asked (see NAEAETANEN and SUMMALA, 1974).

The first question, which the accident analyst puts to the person involved in the accident and his "view" of the accident (in both senses of the expression), is the one concerning the existing access to information on all sensory levels. As the solution of traffic conflicts in the predominant number of the cases is dependant on a visual perceptual input and less on an auditory or kinesthetic-tactile access, the visual conditions on individual, vehicle-lateral and environmental basis have the highest priority (in the course of the interview different perception restrictions can turn out to be important, for instance if acoustic warning signals were not noticed).

Group 1 of the human cause factors (Seven step) subsequently shown as a hypothesis list conveys only exemplarily and as abstracts some of the criteria associated with the hypothesis.

In agreement with a hypothesis-based procedure with the identification of relevant human causes of accident the first hypothesis reads (if this cause is true, it has to be negated):

<u>1. The information necessary for the possible solution of the traffic conflict was objectively available and the person involved in the accident was able to perceive it without obstruction.</u>

- The presence of an "unobstructed perception" is examined exemplarily on the basis of the following criteria: the involved person did not exhibit functional limitations of his eyesight and his central daily visual acuity as well as the other vision functions (e.g. color vision, twilight vision, stereoscopic vision) generally enabled him to use the field of view for the acquisition of information (also taking into account corrective lenses).
- The perception field necessary for the observation of the relevant traffic conditions was not obscured by vehicle-specific perception barriers (characteristics of the vehicle construction, passengers, additional load, changes to the vehicle, wrong or insufficient use of perception assisting devices, condition of the windscreen and other windows, retro-fitted devices).

The first of the seven steps thus refers only indirectly to human characteristics in the sense of an individual reception possibility of sensorily transmitted information. This step designates something like a "gate" for the use of the information. The access opened by this "gate" represents the pre-condition for the second step:

<u>2. The involved person was able and motivated to direct his perception by attentive observation to the relevant/critical situation characteristics based on sufficient perception conditions.</u>

The existence of an "attentive observation" (distributed attention, observation of details) is examined exemplarily on the basis the following criteria:

- The observation accuracy of the person involved was not subject to a diverting influence due to outside stimuli from the driving environment, which limited the distributive attention or which impaired channeling the attention on relevant details.
- The degree of physiological activation of the person involved was not reduced; in particular there were no negative influences on the vigilance (fatigue, exhaustion, drowsiness, microsleep, effects of monotonous driving conditions, influences of the circadian rhythm,

disease symptoms with reduction of the level of activity, (side-) effects of medication, influence of other substances).

The criteria the examination of the second hypothesis was based on comprise features effective in certain situations, which negatively affect the attention attitude of the person involved: external and internal distractors, deactivating factors and influences restricting vigilance restrictive due to substance consumption (alcohol, drugs, medication). The influence of the substances also impairs the cognitive and coordination conditions in the next steps, but it is postulated that a substance consumption particularly and primarily affects the observation ability and attention attitude as a malfunction, thus it is explicitly inquired as specific effect factor in the second step of the Seven steps and is also coded there, if necessary.

If the second hypothesis cannot be negated due to the absence of negative attention-related influences, the next step of the correct identification of the relevant situation characteristics is entered:

3. The person involved recognized the major elements of the situation and completely understood their impact on the further development. With several elements observed simultaneously he kept the track of all of them and identified the major features that were relevant to his actions.

Identifying / recognizing the complete situation and the identification of the major action-relevant characteristics from an event stream is determined exemplarily by the following criteria:

- With available information density, complex perception conditions and/or requirements of the substantial/solid information admission (incessant flood of irritations/sensory overload) the person involved was nevertheless able to understand the substantial features and their meaning.
- During the observation of the traffic the person concerned has filtered the action-relevant information from the information on offer and neglected irrelevant features.

A further criterion in the third step refers to identification problems such as similarity mistakes, mistake or fusion of an object with the background ("Camouflage").
In the consequence the situation is misjudged, which negatively affects the next step of a reliable "risk evaluation". The question concerning the evaluation of a situation regarding its decision relevance (e.g. a palpable threat) follows upon the fourth hypothesis:

4. The person involved was able to evaluate the danger on the basis of the recognized features, by correctly judging the situation and its development concerning its instability and/or its risk content in time.

A timely evaluation and a correct interpretation is examined exemplarily on the basis of the following criteria:

- The person involved correctly estimated speeds and distances of other road users and/or distances of objects or topographic features.
- The person involved combined and correctly interpreted information concerning the driving environment or the behavior of other road users (no "hasty conclusions"; no incorrect assumptions, e.g. due to communication error, confidence error, transfer of responsibility).

In this step all causes of misinterpretations are of interest due to lack of experience, erroneous assessment of physical dimensions (distances, speeds, dimensions, spacial location, length of time), misinterpretations of indications and warning signals and communication errors between road users. Also erroneous evaluations due to "experience problems" (neglecting a risk due to wrong expectations and habits: "nobody ever comes out of this road") are covered by this analysis step. If the situation was judged correctly, however, and understood as a request for action, the next step of action planning follows:

5. The person involved made at least a rudimentary action draft with correct objective and has considered alternative possibilities when planning. He has not also understood what needs to be done, but also how to implement it (correct method).

An indication for the presence of a plan that is as complete and correct as possible can be exemplarily derived from the following criteria:

- The person involved decided on the correct alternative course of action with sufficient time for the selection of the action strategy.
- The person involved did not consciously decide in his planning to violate well-known traffic rules.
- The person involved did not include any "ulterior motives" in his decision-making, which have no recognizable connection to the traffic conditions (counter-productive goals and problematic driving motives, such as superiority, competition, demanding privileges etc.).
- The person involved considered the possible side effects of his planning in the decision-making process and made changes to the plan if necessary and/or considered corrective measures.

For the analysis of the fifth step it has to be considered that for a rational behavior planning and control the time available permits at most a preconscious planning due to quickly recalled "internal sequence models", which developed with the experience of the driver. Questions about decision errors due to incorrect assumptions of the development of the situation thus play a role for the analysis just like skipping the planning phase in favor of a reflex action.

In the context of the explorative accident research persons concerned occasionally report the execution of an action, yet the execution of the intended action was omitted or delayed. In order to be able to analyze this phenomenon more in detail, the sixth step of the pertinent hypothesis is formulated as follows:

6. With the intention of realizing a decision that had been made, no psychologically or physiologically disturbing influences arose, which prevented the implementation of the decision or which prolonged the time required for decision.

The question of a correct and punctual conversion of the principally promising decision can be determined by the criterion of "performance obstacles during the conversion". This can be described based on the following examples:

- The person involved was not subject to a reaction inhibition due to shock phenomena, fright or fear and/or escape reactions.
- During the implementation of the planned action no reaction errors in the sense of inappropriate force, delayed introduction of the reaction or wrong sequence occurred.

The causes of a delayed reaction or of a complete suppression of a reaction are often "shock and block phenomena", confusion due to panic, "hyperactivity / uncontrolled reaction", "a feeling of being overwhelmed" or unsolvable conflicting aims with several equivalent options to react (“to brake or to accelerate”). Also the necessary intensity of the reaction implementation may be negatively influenced herewith (e.g. too weak braking).
In case of unobstructed implementation of the planned decision, possible execution errors move into the focus of the analysis. General action errors and specific control errors prevent the correct execution of a preventive action or emergency and/or avoidance reaction:

7. The person involved did objectively have the chance of intervening in the system by acting and no qualitative or quantitative procedural errors occurred. The person involved implemented the selected mode of operation as intended.

As criteria for a correct und complete action or for an error-free operation the following indicators may be drawn on:

- The action of the person involved was not subject to mix-ups or operating errors.

- The person involved was able to operate the control element without interruption

In the seventh step the question of the concrete execution of the action, after a reaction has occurred, is discussed. Possible action and control errors are explored in the interview. If errors in the execution of the action were not identifiable, however, technical and/or structural system errors in group 2 (e.g. vehicle changes, malfunctions, interface problems) have to be searched for or the respondent has not contributed to the causation of the accident.

In the context of implementing ACASS into GIDAS it appeared to be sensible to simplify the seven Categories of human causation factors, to improve the practicability of this system during on scene investigations for team members without a fundamental psychological background. Thus two changes were performed: First the categories "(2) Observation" and "(3) Recognition" were merged to one category "Information access" und secondly the category "(6) Selection" was merged into the category "(7) Operation". These remaining five categories may easily be converted back into a seven step system with the knowledge of the specific influence criteria of the categories.

In the following the seven-step system for the collection of causes of accidents is to be clarified by an example. This example is based on a real-life traffic accident, which was collected in the context of the GIDAS accident research project.

Example of use of ACASS in GIDAS

<u>Description of an accident:</u>
The 46-year-old driver of an AUDI A6 (built in 2005) drove along a single-lane highway on the ramp leading to a bridge. At the end of a right hand bend, immediately before he came to the bridge he lost control of his vehicle, ran off the road to the left and collided with the left hand guard rail behind the bridge. The driver was questioned in hospital. He stated that he drove around the right hand bend, when suddenly there was quite a large animal on the bridge. Then he oversteered to the left and lost control.

In the context of the investigations of the GIDAS research team, it turned out however that the driver possibly briefly used the telephone function of his navigation system before the accident. When the research team arrived at the scene of the accident the system was still in the telephone mode ready to dial a number (cf. figure 4). Thus it seems also possible that the driver was distracted from his driving task and this distraction caused the accident. The fact that he wanted to avoid hitting an animal could also be a protection statement of the driver, particularly as it appears improbable that larger animals stay on bridges.
Using the causation codes as shown in illustration 4, three causes of accident factors were recorded. First the information from the interview with the driver was coded. The driver stated to have suddenly seen an animal on the road and steered, possibly due to fright, too far to the left. Here an overreaction due to fright was coded from the human factors.

<u>Code 1612</u>
Group 1 (human factors), category 6 (selection of the action), influence criterion 1 (performance of obstacles), indicator 2 (fright/shock).

On the other hand as another factor of influence the animal on the road is coded from the group 'environment'

<u>Code 341</u>
Group 3 (factors from the environment), category 4 (additional external influences), influence criterion 1 (animals).

As these causes of the accident were stated by the driver during questioning in the hospital, the source of information was coded here as 2. If the statement made by the driver was possibly only a defensive maneuver, doubt concerning the reliability of the code could be expressed by marking the following check boxes.

Then the assumption of the accident investigation team that operating the telephone possibly distracted the driver was coded. This is a cause factor from the group of the human factors

Code 1211
Group 1 (human factors), category 2 (observation), influence criterion 1 (distraction from inside the vehicle); Indicator 1 (operation of devices)

As this cause factor is an assessment of the accident investigation team, the source of information 9 was encoded here.

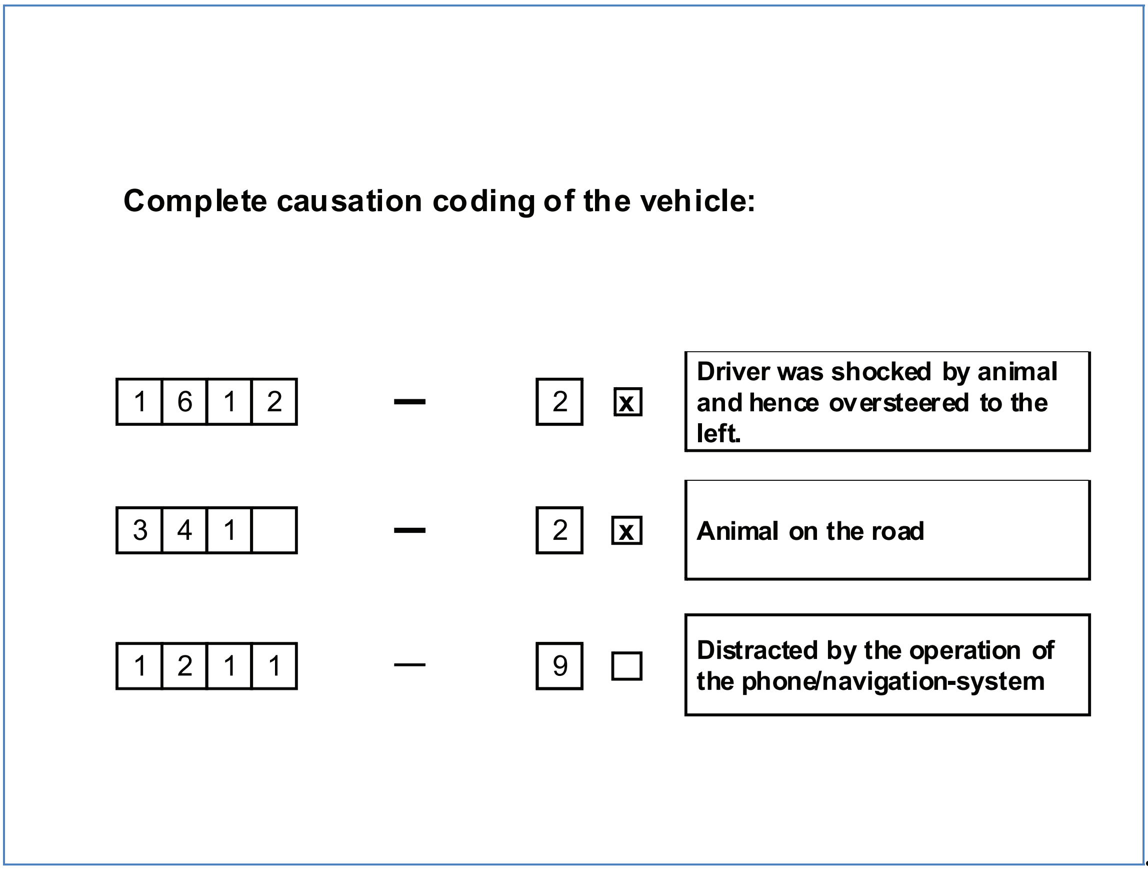

Figure 4: ACASS coding of the example.

Figure 5: Direction and path of the Audi.

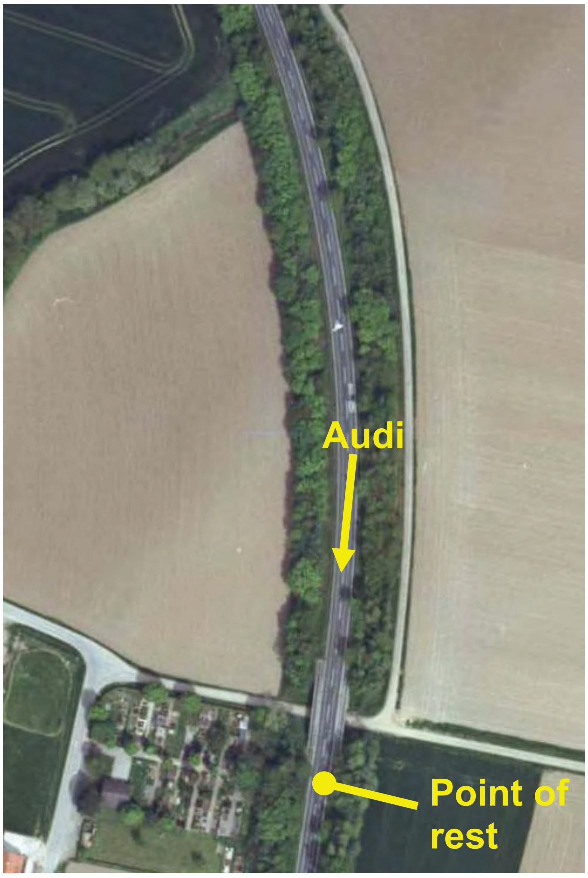

Figure 6: Aerial picture of the site of the accident.

Figure 7: Point of rest of the vehicle.

Figure 8: Interior of the vehicle.

Results of the implementation in GIDAS

561 accidents collected within GIDAS by June 2008 were evaluated, of these 412 cases (73%) contained causation codes. Thus 687 involved persons were available for analysis, of which 457 persons contributed to the emergence of the accident and had a causation code. A population of cases resulted with a distribution similar to all accidents in GIDAS, for instance based on the proportion of traffic participants, cars 54%, trucks 6%, bicycles 21%, 8% pedestrians, 9% motorcycles. Human causes were determined for all road users in over 92% of the cases, with the exception of accidents involving busses and streetcars (figure 9). Environmental factors obviously have less effect on the development of accidents involving passenger cars and trucks than on accidents involving pedestrians and motorcyclists as traffic participants.

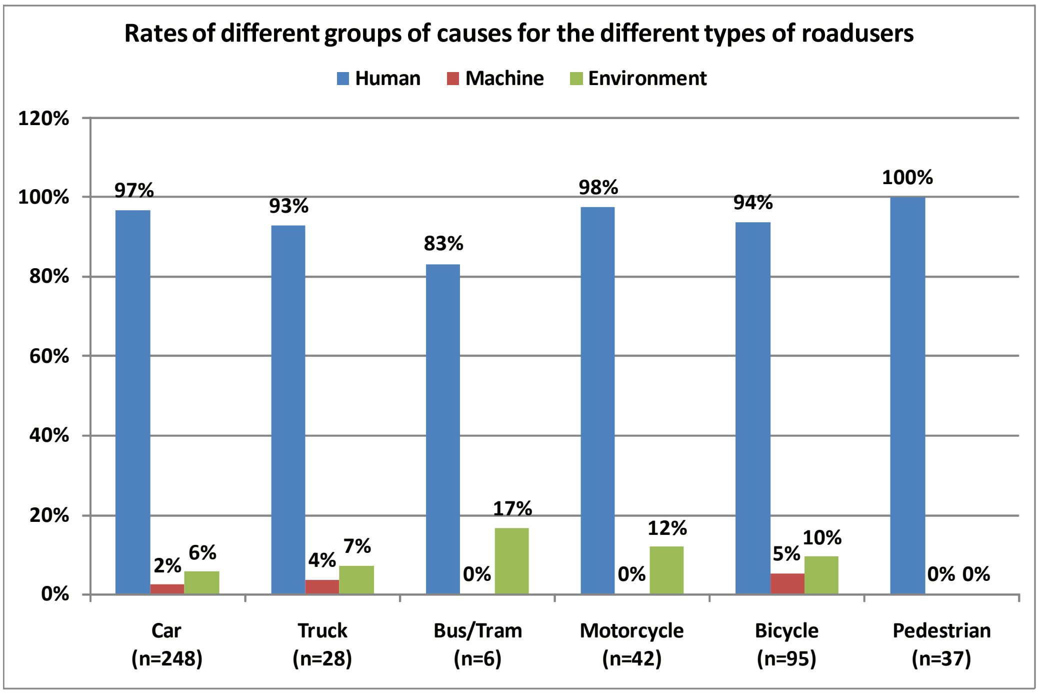

Figure 9: Frequency of the indicated causation factors in the accident documentation of GIDAS

A coding of the human cause factors was done as a complete code in 91,2% of the cases, in 6,8% of the cases without an indicator and in 2% of the cases only the group could be specified (figure 10).

The group of the human cause factors consists of categories of the ranges of the perception of humans, the evaluation of the perception and the resulting action, which is called 7 Steps because of the possible 7 categories.

In 20% of the cases no complete access of the participant to all information was possible. Furthermore 18% of the participants that contributed to the emergence of the accident did not observe the Situation with full attention. 31% of the human factors relate to failures with the recognition of the traffic situation and respectively about 25% relate to errors when evaluating the situation and when planning an action to handle the situation. Only 10% of the participants had problems with the selection and initiation of an action and only about 1% had an action error like mixing up the brake-pedal with the accelerator (figure 11)

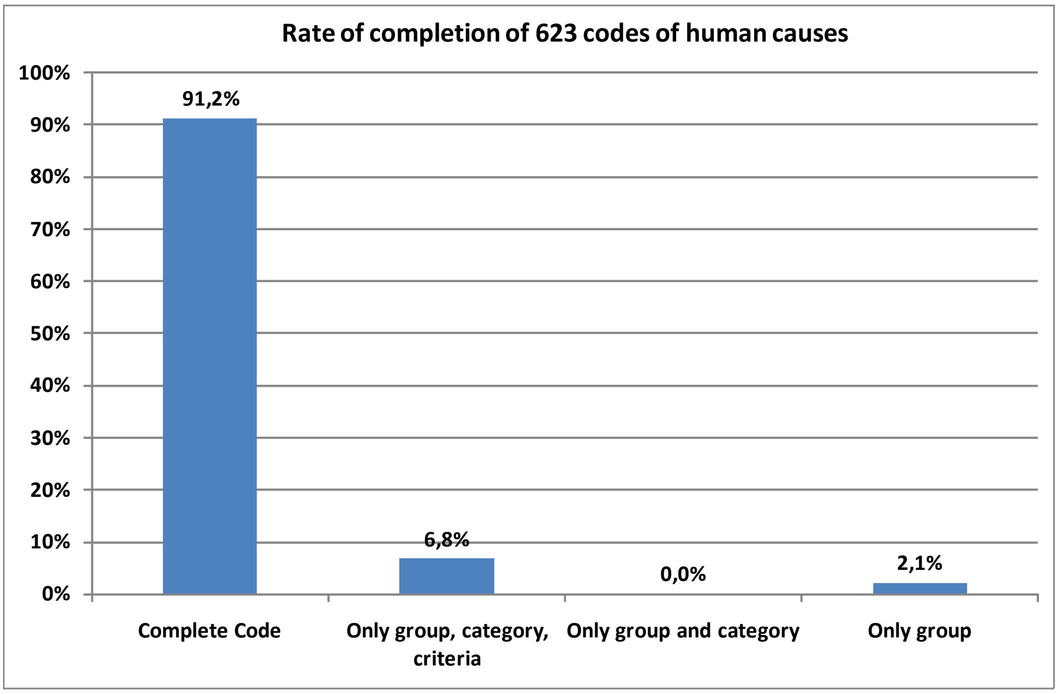

Figure 10: Completion of human factors.

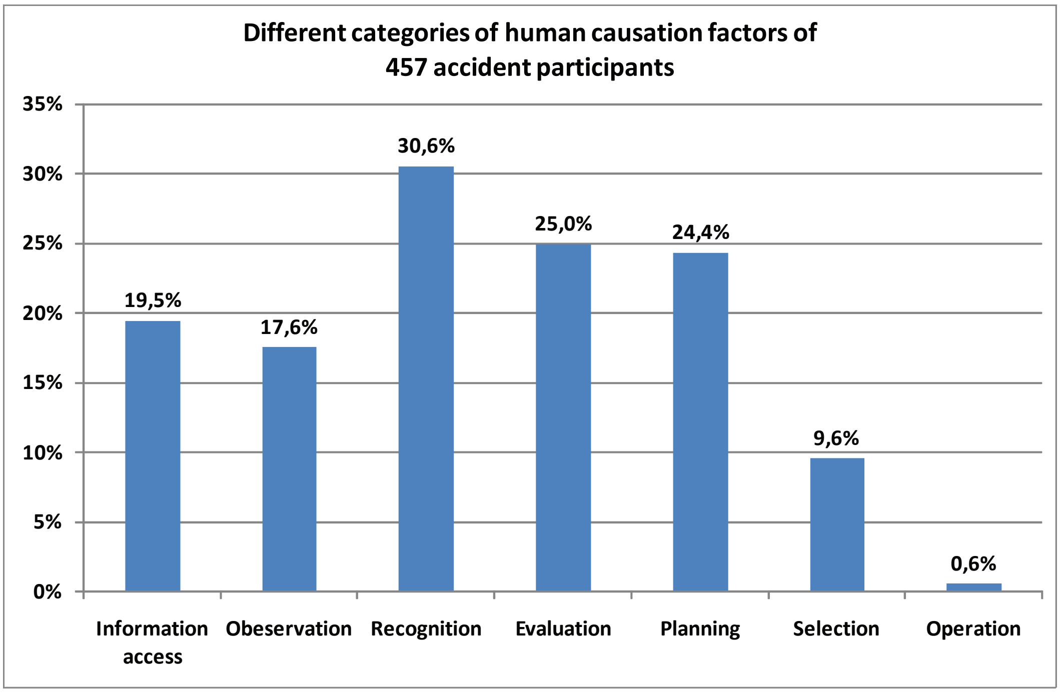

Figure 11: Frequencies of the categories of the human causation factors.

With the more differentiated evaluation of the categories, using the criteria, a wrong focus of attention of the driver appears with an incidence of 29 % (figure 12). This can be regarded as a substantial influence parameter for accident causation. But also the intentional breach of rules with an incidence of 14 % proves to be a frequent accident causation factor.

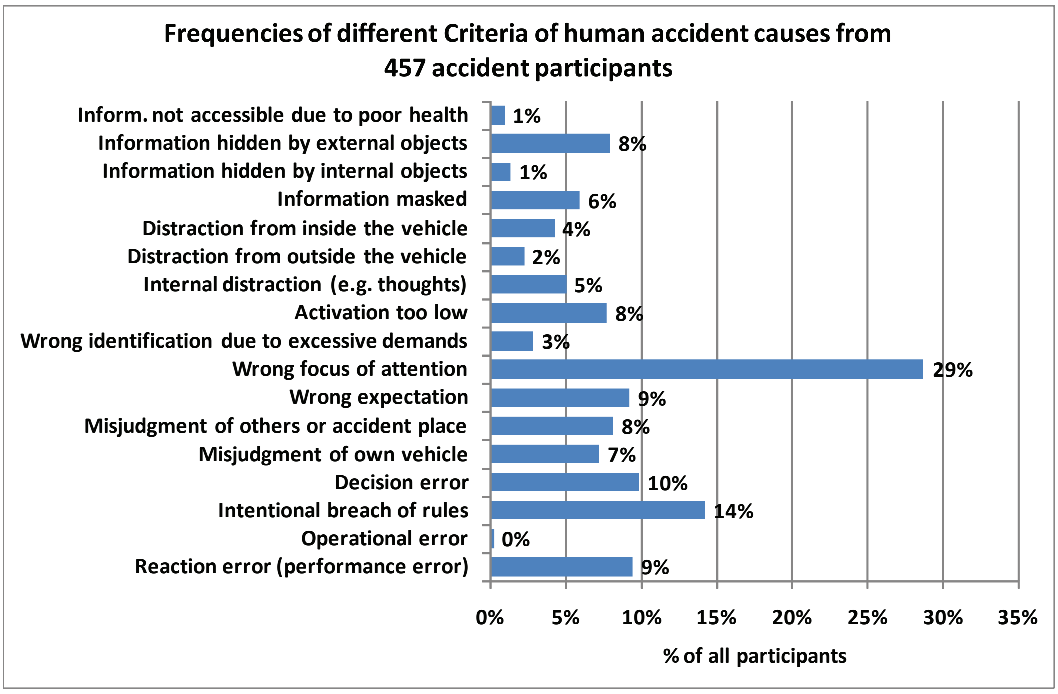

Figure 12: Frequencies of the criteria within the different categories of the human causation factors.

When evaluating the most frequent indicators of the different criteria, the “wrong observation strategy” and also the “wrong assumption concerning the outcome of a situation“ appear most frequently from altogether 669 mentions. But also “excessive speed” and the “focus towards the wrong road user”, the “wrong estimation of distance of other road users” as well as “driving under influence of alcohol” appears as frequent indicators of human causes:

12063	Wrong observation strategy	n=87
14012	Wrong assumption concerning the outcome of a situation	n=36
14022	Excessive speed	n=27
12061	Focus of attention towards the wrong road user	n=25
13022	Wrong estimation of distance of other road users	n=20
12042	Driving under influence of alcohol	n=18

Conclusions

In particular due to the increasing use of intelligent technical aids of the vehicle assistant systems, it becomes more and more difficult to evaluate the contributions of these electronic systems built in the vehicles concerning their influence on accident causation and accident avoidance. Active safety and above all the knowledge of the causes of traffic accidents gain at present an ever-increasing importance for the development of safety measures. The objective was the creation of a coding system of causes of accidents and/or influencing parameters on the accidents, which can be used in the framework of accident research. This system should contain the individual components "human - vehicle - environment" and a methodology for the collection of the important information, beyond that it should also make the causes and/or influence parameters available for evaluation/processing on computers.

The objective of finding a suitable system to supply the relevant parameters for the GIDAS on scene investigations and also other in-Depth-investigations was achieved and the system has been judged as suitable after it underwent a practice test.

The practice test resulted in a satisfactory usage rate of coding application for the accident documentation. The team members had undergone psychological training and the codes selected by the team were correctly chosen in the majority of the cases. Next to three days of traffic psychological training, the quality control arrangements also included case reviews with plausibility validation of the codes as well as a random operation of the traffic psychologist in the accident research team.

The coding should be a component of an on scene accident data collection system. Thus information collected from persons and vehicles involved in an accident can be recognized as parameters influencing the accident development and processed for use on computers based on the coding system.

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